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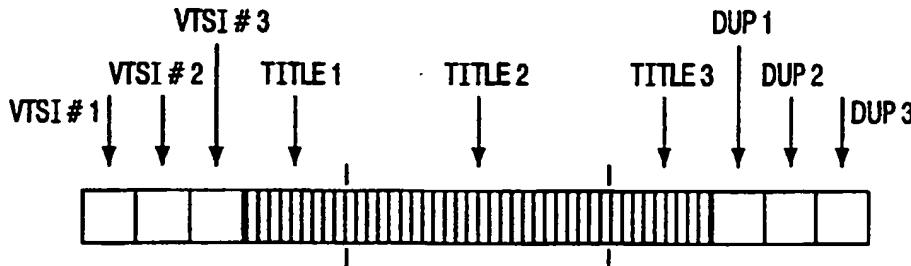
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(54) Title: DATA ALLOCATION IN DVD RECORDING



(57) Abstract: A method of recording an encoded bit stream, said encoded bit stream representing a plurality of video objects comprising a sequence of cells together constituting a part of an MPEG2 Program Stream, on a disc like record carrier, such as an optical disc. The method comprises recording multiple series of contiguously arranged video objects constituting multiple video object sets on said disc with corresponding multiple management information comprising attribute information of the corresponding video object set. The management information constituting with a video object set a playable video title. The multiple video object sets are combined into a single combined video object set and the multiple management information is preceding said combined video object set.

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Data allocation in DVD recording.

The invention relates to a method for recording encoded information signals as recited in the preamble of claim 1 on a disc like record carrier, such as an optically readable disc. The invention further relates to a recording apparatus for performing the method.

5

The DVD-Video format for optically readable discs is defined in the DVD Specifications for Read-Only Disc, part 3: Video Specifications (version 1.0, August 1996). Relevant parts therefrom are being disclosed in for instance European Patent Application EP 724 264 and US Patent 5 784 528, respectively document D1 and D2 in the list of referred documents that can be found at the end of this description. Both documents are incorporated by reference herein.

10 The DVD-Video format as defined in the above mentioned Specifications for READ-Only Disc and disclosed in D1 and D2 was created for storing movies and other video content on read-only DVD media. Some of the features of the DVD-Video format make it  
15 less suitable for real-time recording applications.

However, it is desirable to create and record video streams and associated data structures on rewritable media in real time which are should preferably be almost identical to the structures defined in the DVD-Video format. Such rewritable discs should be play back compatible with the majority of the installed base of consumer DVD-Video players. The  
20 method according to the invention describes a novel and inventive format for DVD-Video compatible real-time recording of video streams, referred to hereinafter to as Real Time DVD Video Recording or shortly DVD-Video Recording. The format defined is intended for home video recording on an optical medium which is playback compatible with DVD-Video players.

25 The above-mentioned DVD-Video format demands that data for a Video Title Set (VTS) be allocated contiguously. This implies that Titles cannot be fragmented, except for interleaving. A Title in this respect is defined to be a user accessible unit in Title Search Pointer table of the DVD-Video format. This requirement implies that a user should see a

disc as a linear recording space equivalent to a tape where Titles are presented to user in order of recording.

However, this gives all kinds of problems when part of the data is overwritten with new recordings such as occurs with adding, appending, overwriting or deleting a Title.

5 A possible solution would be to organize all titles in one Video Title Set, preceded by one Video Title Set Information area (VTSI) and a corresponding Video Manager General Information area (VMGI). However, this has the disadvantage that no longer can be distinguished between different parameter sets for each Title. Such as for example the video parameters picture resolution, frame rate, aspect ratio and bit rate.

10

In consequence, amongst other things, it is an object of the invention to obviate the above-mentioned disadvantages. According to one of its aspects a method of recording to the invention is characterized as recited in the characterizing part of claim 1.

15 Now each playable title may have its own management information. Locating the management information in advance of all video objects has the advantage that the video object sets may be regarded as one, composite video object set. This leads to a simplified addressing.

20

Further advantageous aspects of the invention are recited in other, dependent claims.

These and further aspects and advantages of the invention will be apparent from and elucidated in more detail hereinafter with reference to the disclosure of preferred 25 embodiments, in particular with reference to the appended figures in which,

Fig. 1 illustrates a linear tape model in view of some typical video recording actions;

Fig. 2 illustrates the structure of the video area on a disc according to the DVD Video format; while

30 Fig. 3 shows in more detail the arrangement of a Video Object Set (VOBs) of Fig. 1 in Video Objects (VOB) and Cells;

Fig. 4 shows a possible arrangement of all Titles in one Video Title Set and

Fig. 5 shows an arrangement of multiple Video Title Sets according to an embodiment of the invention;

Fig. 6 shows a recording apparatus according to a first embodiment of the invention, the respective units therefrom being illustrated in more detail in the following figures of which

- 5 Fig. 7 shows an A/V input unit;
- Fig. 8 shows a CODEC unit;
- Fig. 9 shows an A/V output unit;
- Fig. 10 shows a drive unit, and
- Fig. 11 shows a system control unit.

10

Fig. 1 illustrates the concept of a linear tape model in view of some typical recording actions. Fig. 1A illustrates a recording of a first Title 1 in a linear address space of a DVD disk with a remaining free space 2. According to the DVD-Video format, the data is allocated contiguously. Fig. 1B illustrates adding a Title 2 after the first Title 1. Fig. 1C shows appending to the existing Title 1, the append part indicated by the arrow. Part of the Title 2 of Fig. 1C is overwritten. Fig. 1D illustrates partly overwriting the Title 2. Fig. 1E shows deleting Title 3 of Fig. 1D.

Fig. 2 illustrates the DVD video area according to the DVD Video format. It is noted a Lead\_in zone, a Lead\_out zone and a file system, although present, are not depicted in this figure. The DVD Video area starts with a Video Manager Area (VMG) comprising a Video Manager General Information (VGMI) area, an Video Object Set (VOBS) area and a Duplicate (DUP) area containing a copy of the Video Manager General Information (VGMI) area. A Video Object Set (VOBS) is a collection of contiguously recorded VOBs as will be illustrated hereinafter with reference to Fig. 4.

25 The Video Manager (VMG) contains information about the recorded video data and a Title Menu. This is a menu that gives the user access to Play Lists and optionally to Full Titles.

A Play List is a Title representing a play back sequence of Cells from one Recording. A Cell is a sequence of one or more Video Object Units (VOBU). The first VOBU of a Cell shall contain video data. A Cell is the basic presentation unit for the 30 Program Chains (PGC), which is a playback sequence of Cells for the presentation of a Menu or a Title.

A full Title represents one Recording. When a Full Title is played, all complete Cells contained in the Recording are played in the order of data allocation in the Video Object Set for Titles in a Video Title Set. (VTSTT\_VOBS).

A Recording is a contiguous piece of the Video Object Set for Titles in a Video Title Set (VTSTT\_VOBS). A Video Object (VOB) is (a part of) a sequence of contiguously recorded Cells, together constituting (a part of) an MPEG-2 Program Stream containing

5       MPEG-2 Program Stream packs such as defined in ISO/IEC 13818-1 related to MPEG-2 systems, document D3 in the list of referred documents that can be found at the end of this description.

The Title Search Pointer Table is one of the elements of the Video Manager. This table lists all available Play Lists and Full Titles on the disc. It is a starting point for  
10 finding the data that is relevant for playing back a Title.

Free Space is a recording which is represented by a Free Space Title in the Title Search Pointer Table. If the last Recording is free space, it is not represented in this table. A Free Space Title is a Full Title or Play List Title which cannot be played back as the related Program Chain Information contains a pre-command to prevent this. Time\_Play(),  
15 Time\_Search(), PTT\_Play() and PTT\_Search() for a Free Space Title are blocked. The Cell information in the Program Chain of a Free Space Title may not be reliable.

After the Video Manager (VMG) several Video Title Sets (VTS#1, VTS#2 ..) may follow, each Video Title Set (VTS) preceded by Video Title Set Information (VTSI) containing information with respect to the corresponding Video Title Set (VTS) such as  
20 audio and video parameters. Following the Video Title Set Information (VTSI) are corresponding Video Object Set (VOBS) containing MPEG-2 video for respectively Menus and Titles. Each Video Title Set close with a Duplicate area (DUP) containing a copy of the Video Title Set Information (VTSI).

Fig. 3 illustrates in more detail the arrangement of a Video Object Set (VOBs) of Fig. 2 in contiguously recorded Video Objects (VOB#1, VOB#2,...) and Cells (C\_IDN=1, C\_IDN=2,...). VOBs which are used for the menus are stored in the Video Manager VOBS (VMGM\_VOBS). VOBs which are used for the Titles are stored in the VTS Title VOBS (VTSTT\_VOBS).

Fig. 4 shows a possible arrangement of all Titles in one Video Title Set.  
30 Following the Video Manager (VMG) area, is only one Video Title Set preceded by one Video Title Set Information (VTSI) area and a corresponding Duplicate (DUP) area. The Video Title Set (VTS) contains in this example two Titles (Title1 and Title 2). The corresponding Presentation Control Information (PCI) and Data Search Information (DSI), not shown in Fig 4, is dispersed in corresponding Navigation Packs (NV\_PCK) in each

Video Object Unit (VOBU) of the Video Object Set VOBS. According to the DVD Video format, a Video Title Set (VTS) has a separate reference point in the Navigation Pack (NV\_PCK). Each Navigation Pack (NV\_PCK) has a Logical Block Number (NV\_PCK\_LBN) that is relative to this reference point (VOBS Offset in NV-PCK).

5 When the real time data of the Video Object Set (VOBS) is overwritten by a New Title, the Video Title Set Information (VTSI) and the Video Manager Information (VMGI) are updated.

10 However, the embodiment according to Fig. 4, is limited in that the Video Title Set (VTS) may only contain one parameter set for video and audio. Such as for example parameters related to aspect ratio, Long Play mode versus Normal Play mode, picture size and Video Coding Mode (MPEG1 or MPEG2) and so on. An embodiment according to the invention that overcomes this disadvantage will be disclosed with reference to Fig. 5

15 Fig. 5 shows an arrangement of multiple Video Title Sets according to an embodiment of the invention. This arrangement allows multiple interleaved Video Title Sets (VTS#1, VTS#2...). The real time data of the Video Title Sets (TITLE1, TITLE2, TITLE3) is arranged consecutively while the corresponding Video Title Set Information (VTSI#1, VTSI#2, VTSI#3) is arranged separately. When real time data is overwritten, this info structures are adapted such that only references to the remaining data structures are made. Players do not notice that the real time data of various Video Title Sets is arranged in an 20 interleaved manner. With reference to Fig.5A, which shows only one Title (TITLE1), Fig. 5B shows an additional Title (TITLE2) and Fig.5C two additional Titles (TITLE2 and TITLE3). It is noted that each Navigation Pack (NV-PCK) has a Relative Block Number (NV\_PCK\_LBN) that is relative to the first sector containing real time data of any Video Title Set (VTS). This is regarded as the common reference point for all real time data.

25 The Video Title Set Information (VTSI#1, VTSI#2, VTSI#3) files are located in a separate area on the disc, preferably in front of any real time data structure. This is also done for the corresponding Duplicate files (DUP1, DUP2, DUP3). Each Video Title Set is allowed to have its own video and audio parameters such as defined in the corresponding Video Title Set Information (VTSI)

30 Fig. 6 shows a recording apparatus according to a first embodiment of the invention. The recording apparatus is composed of several units. One unit is the A/V input unit 1. The A/V input unit 1 receives image and sound signals at antenna input terminal 2 and an external sound/image input terminal 3. The antenna input terminal 2 is adapted to receive broadcasted modulated A/V signals transmitted by either satellite, terrestrial or cable source.

The external sound/image input terminal 3 is adapted to receive a non modulated audio signal or a non-modulated video signals generated directly by respectively an audio or a video source.

Fig. 7 illustrates the A/V input unit 1 in more detail. A tuner 5 , which is connected to the antenna input terminal 2, demodulates the modulated A/V antenna signals and outputs the demodulated signals to a suitable A/V demultiplexing unit 6 for separating audio signals from video signals . An audio A/D converter unit 7 outputs a digital audio signal A and a NTSC/PAL/SECAM decoding unit 8 , comprising a video A/D converter, outputs a digital video signal V. These signals A and V are outputted to a encoding/decoding unit 9, which is illustrated in more detail in Fig. 8. The encoding/decoding unit 9 compresses and encodes the signals A and V, respectively by an audio encoder 10 and a video encoder 11, converts them to a multiplexed and compressed stream conforming to Video Recording specifications, employing a multiplexer 12. To this purposes the audio encoder 10 and video encoder 11 are adapted to perform source compression according to a specific standard for compression, such as for example MPEG-2 for audio and video.

The compressed and multiplexed stream is submitted via a track buffer 13, which absorbs rate fluctuations stemming from intermittent recording and data reproduction from a disc, to a drive unit 14. The encoding/and decoding unit 9 also expands a compressed stream read from a recording medium by the drive unit 14 and outputs separately an audio signal A and a video signal V to the A/V output unit 15. To this purpose, the encoding/decoding unit 9 comprises a suitable A/V decoder 16 for decoding the compressed audio and video source signals.

The A/V output unit 15, which is illustrated in more detail in Fig. 9, comprises an audio D/A converter 17 for outputting sound signals to an external sound output terminal 18. The A/V output unit 15 further comprises a video encoder - D/A converter unit 19 for outputting video signals to an external image output terminal 20.

Fig. 10 illustrates the drive unit 14 in more detail. This unit 14 receives the compressed stream generated by the encoding/decoding unit 9, and adds an error-correction code by a suitable error correction processing unit 21 to the stream. Next a channel modulation/demodulation unit 22 converts the stream with error-correction code to channel bits adapted for recording on a recording medium 23. In case of a DVD-disc the EFM+ modulation scheme is being applied. Recording and reading in case of a recording medium 23 of the optical type, is performed by a laser comprised in an optical head unit 25. A laser power control unit 24 is controlling the laser. Reflected signals from the recording medium

23 are being converted by an amplifier and waveform equalizer circuit 26 into two-value signals. The resultant compressed stream is further demodulated by the modulating/demodulation unit 22 , error corrected by the error correction processing unit 21 and outputted to the encoding/decoding unit 9 via track buffer 13.

5           A servo circuit 27, connected to the amplifier and waveform equalizer circuit 26, controls the positioning of the optical head unit 25 relative to the recording medium 23 and the rotational velocity of the recording medium 23 by controlling rotational driving means 28.

10          A system control unit 29, as shown in Fig. 11, controls each block and perform file control, control information management and track buffer control. To this purpose a system control processing unit 30 is provided that is being connected to memory means 31 loaded with a suitable operation system. Operator input means 32 and operator output means 33 are connected to the memory means 31. The operator input means 32 comprising for instance keying means and the operator output means comprising display means.

15          Although the invention has been described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus, various modifications thereof may become apparent to those skilled in the art, without departing from the scope of the invention, as defined by the claims. The invention can be 20 implemented by means of both hardware and software, and that several "means" may be represented by the same item of hardware. Further, the invention lies in each and every novel feature or combination of features. It is also remarked that the word 'comprising' does not exclude the presence of other elements or steps than those listed in a claim. Any reference signs do not limit the scope of the claims.

**LIST OF REFERRED DOCUMENTS**

(D1) European Patent Application EP 724 264

(D2) US Patent 5 784 528

5 (D3) ISO/IEC 13818-1 : 1995 Information Technology – Generic Coding of moving pictures  
and associated audio information : Part 1 : Systems (MPEG2-systems)

**CLAIMS:**

1. A method of recording an encoded bit stream, said encoded bit stream representing a plurality of video objects comprising a sequence of cells together constituting a part of an MPEG2 Program Stream, on a disc like record carrier, such as an optical disc, said method comprising:

5 recording a series of contiguously arranged video objects as a video object set on said disc,

recording management information comprising attribute information of the recorded video object set, wherein

said management information precedes said video object set and constitutes therewith a playable video title,

characterized by,

recording at least a second series of contiguously arranged video objects constituting a second video object set and corresponding second management information on said disc, wherein

15 the at least two video object sets are combined into a single video object set and the first and the at least second management information precedes said combined video object set.

2. A method according to claim 1, wherein each video object contains navigation

20 information employing a common reference address.

3. A method according to claim 2, wherein said reference address is at the beginning of the first series of video objects following the management information.

25 4. A method according to claim 3, wherein the attribute information comprises picture resolution and/or video coding mode of the video object set.

5. A method according to claim 4, wherein a playable video title, a video object set and the management information corresponds respectively to a Video Title Set (VTS), a

Video Title Set Video Object Set (VTSTT-VOBS) and the Video Title Set Information (VTSI) of the DVD-Read Only Video Specification.

6. A method according to claim 5, wherein the navigation information  
5 corresponds to a Navigation Pack (NV-PCK) of the DVD-Read Only Video Specification and the common reference address corresponds to the first logical block number of the first Video Object Set of the series of Video Objects Sets.

7. A recording apparatus for recording an encoded bit stream, representing a  
10 plurality of video objects comprising a sequence of cells together constituting a part of an MPEG2 Program Stream, on a disc like record carrier, such as an optical disc, the recording apparatus comprises

recording means for recording a series of contiguously arranged video objects as a video object set on said disc and for recording management information comprising  
15 attribute information of the recorded video object set,

wherein said management information precedes said video object set and constitutes therewith a playable video title,

characterized in that, the recording apparatus comprises

20 system control means adapted to control recording of at least a second series of contiguously arranged video objects constituting a second video object set and corresponding second management information on said disc, wherein

the at least two video object sets are combined into a single video object set and the first and the at least second management information precedes said combined video object set.

25 8. A recording apparatus according to claim 7, characterized in that,

the system control means are adapted to include in each video object navigation information employing a common reference address.

30 9. A recording apparatus according to claim 8, wherein said common reference address is at the beginning of the first series of video objects following the management information.

10. A recording apparatus according to claim 9, characterized in that,

the system control means are adapted to include picture resolution and/or a video coding mode of the video object set as attribute information.

11. A recording apparatus according to claim 10, wherein a playable video title, a video object set and the management information corresponds respectively to a Video Title Set (VTS), a Video Title Set Video Object Set (VTSTT-VOBS) and the Video Title Set Information (VTSI) of the DVD-Read Only Video Specification.
12. A recording apparatus according to claim 11, wherein the navigation information corresponds to a Navigation Pack (NV-PCK) of the DVD-Read Only Video Specification and the common reference address corresponds to the first logical block number of the first Video Object Set of the series of Video Objects Sets.

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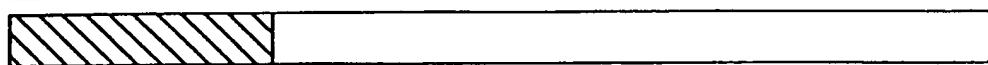
**1**

FIG. 1A

**1****2****3**

FIG. 1B

**1****2****3**

FIG. 1C

**1****2****3****4****5**

FIG. 1D

**1****2****3****4****5**

FIG. 1E

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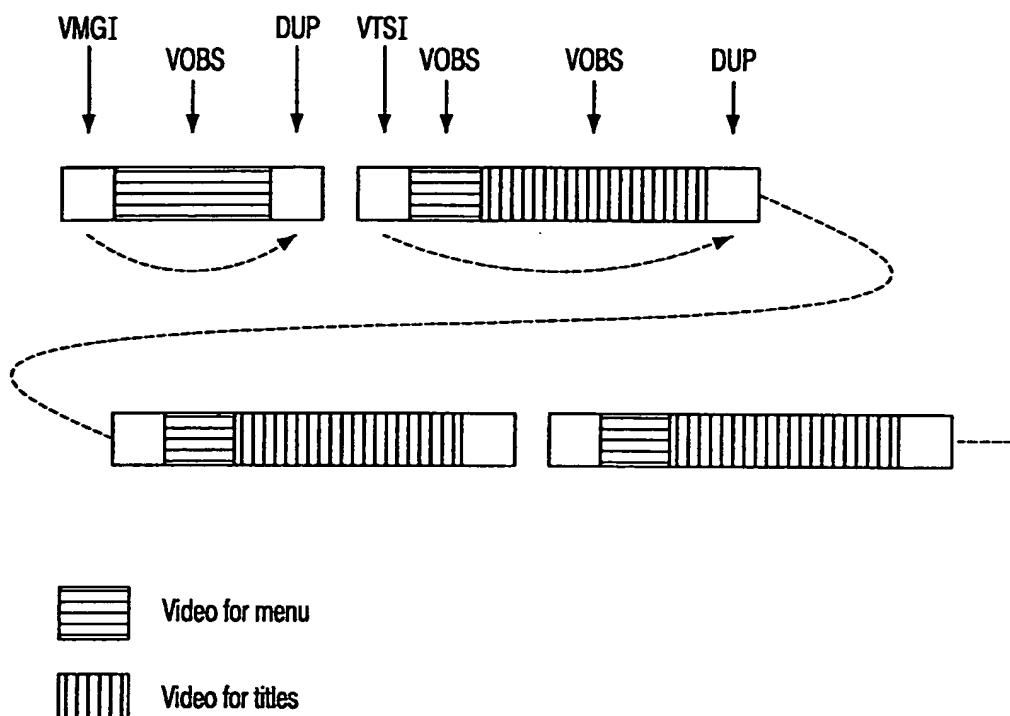


FIG. 2

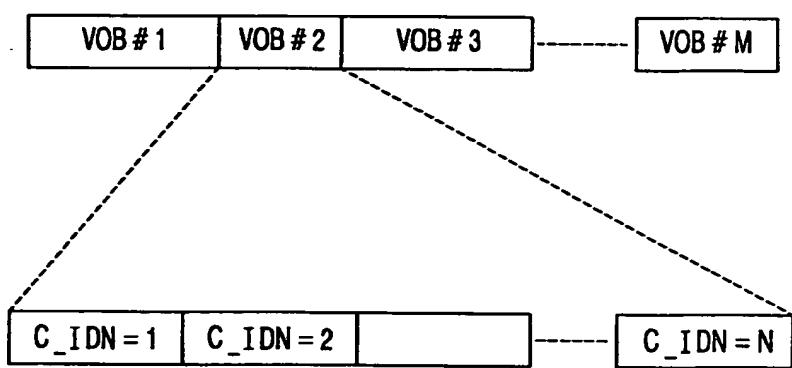


FIG. 3

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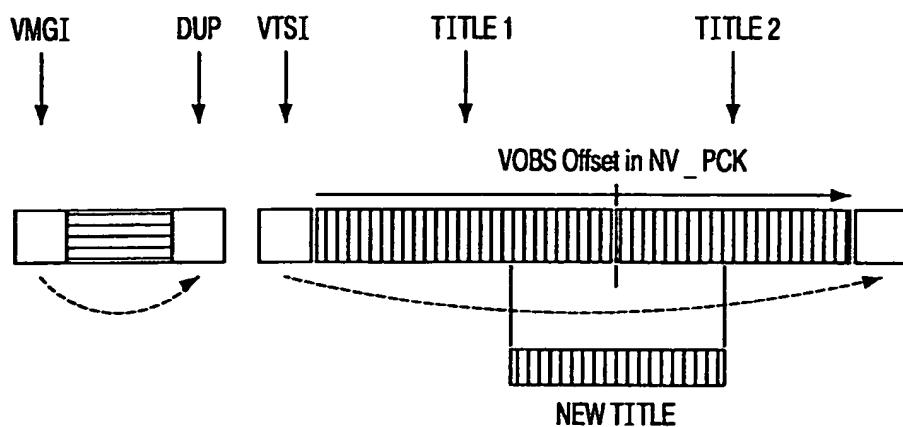


FIG. 4

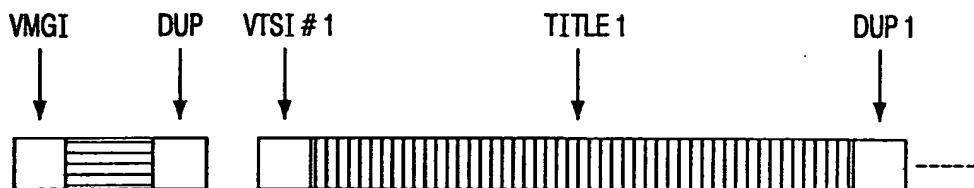


FIG. 5A

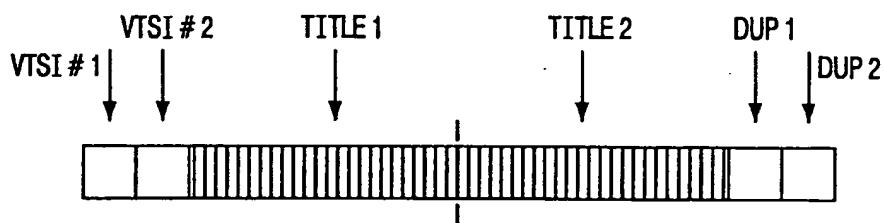


FIG. 5B

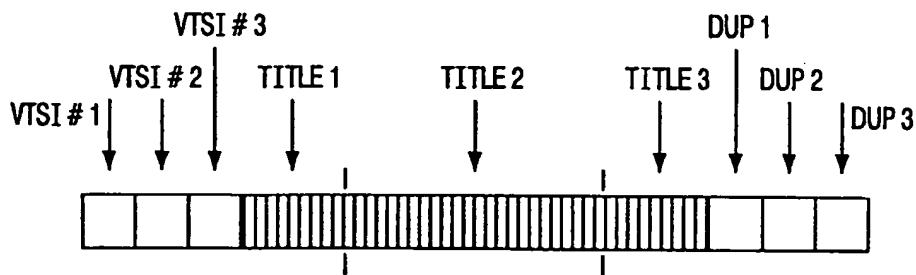


FIG. 5C

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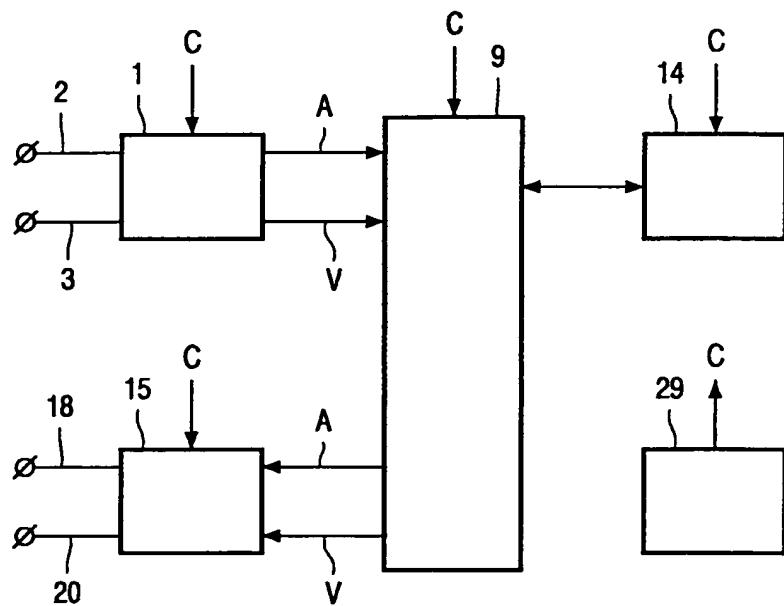


FIG. 6

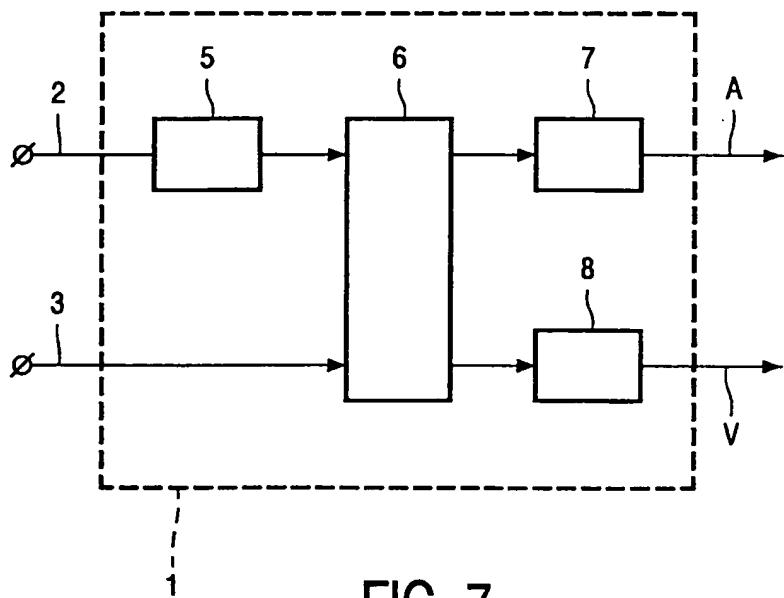


FIG. 7

5/6

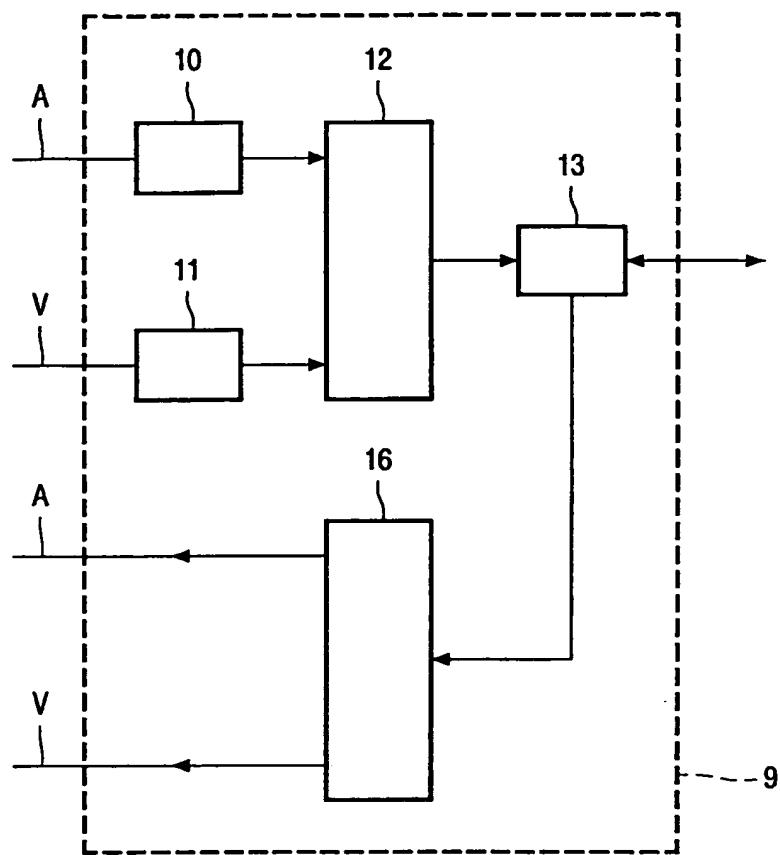


FIG. 8

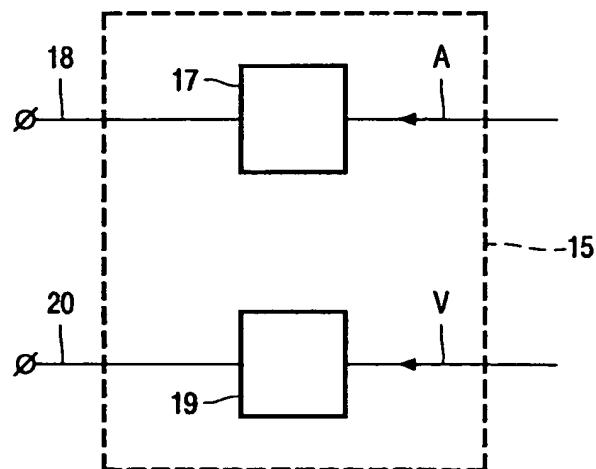


FIG. 9

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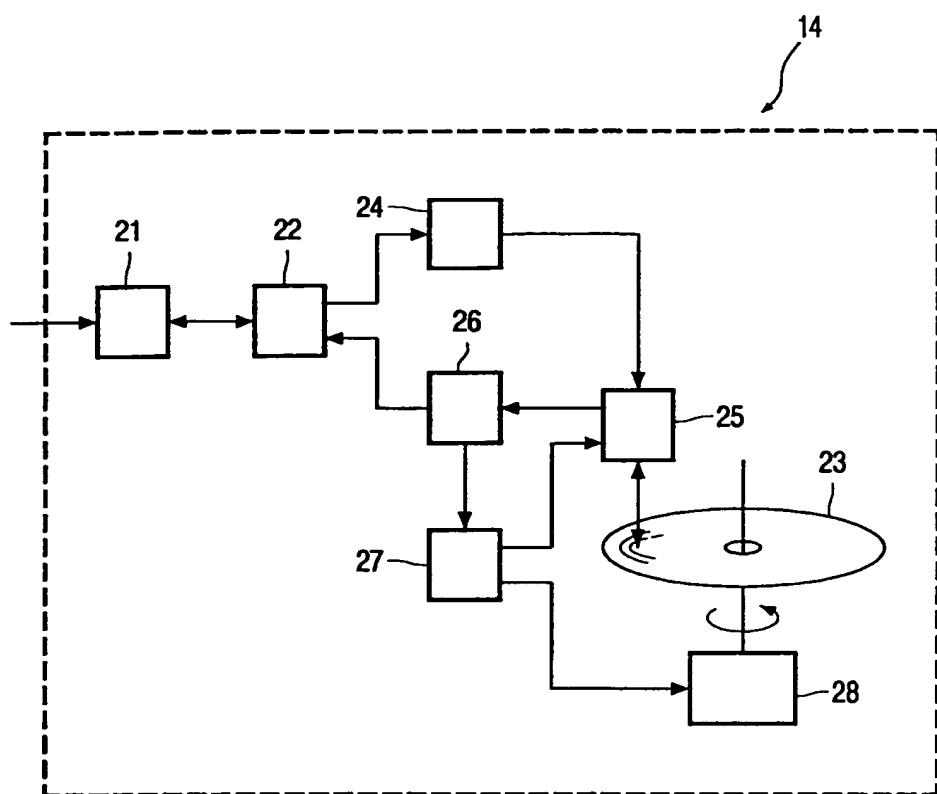


FIG. 10

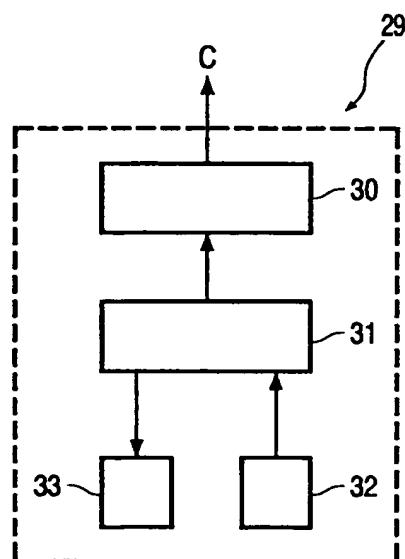


FIG. 11

# INTERNATIONAL SEARCH REPORT

Inten. Appl. Application No.

PCT/EP-00/05891

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 G11B27/034 G11B27/30 G11B27/32 G11B20/12 H04N5/85  
//H04N5/775, H04N9/804, G11B7/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G11B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	EP 1 043 726 A (PIONEER ELECTRONIC CORP) 11 October 2000 (2000-10-11) the whole document	1,7
P,X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) & JP 11 273262 A (PIONEER ELECTRONIC CORP), 8 October 1999 (1999-10-08) abstract & JP 11 273262 A: paragraph '0006!-paragraph '0022!; figure 1-5	1,7
P,A	— —/—	4,9

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

\* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
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- \*Z\* document member of the same patent family

Date of the actual completion of the international search

20 November 2000

Date of mailing of the International search report

27/11/2000

Name and mailing address of the ISA

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Authorized officer

Daalmans, F

**INTERNATIONAL SEARCH REPORT**

Intern. Application No

PCT/EP 00/05891

**C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) & JP 11 273314 A (PIONEER ELECTRON CORP), 8 October 1999 (1999-10-08) abstract & JP 11 273314 A: figure 4 and 5	1,7
P,A	—	4,9
P,A	EP 0 929 072 A (TOKYO SHIBAURA ELECTRIC CO) 14 July 1999 (1999-07-14) column 60, line 9 -column 87, line 6	1-12
P,A	WO 00 30112 A (KONINKL PHILIPS ELECTRONICS NV) 25 May 2000 (2000-05-25) the whole document	1-12
L	the same applicant	
P,A	— EP 0 942 426 A (NIPPON COLUMBIA) 15 September 1999 (1999-09-15) the whole document	1,7
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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

Intern. Appl. No.

PCT/EP 00/05891

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## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>PHN 17.516W0</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/EP 00/ 05715</b>	International filing date (day/month/year) <b>21/06/2000</b>	(Earliest) Priority Date (day/month/year) <b>25/06/1999</b>
Applicant <b>KONINKLIJKE PHILIPS ELECTRONICS N.V.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.  
 It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
  - a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
    - the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
  - b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :
    - contained in the international application in written form.
    - filed together with the international application in computer readable form.
    - furnished subsequently to this Authority in written form.
    - furnished subsequently to this Authority in computer readable form.
    - the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
    - the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
2.  **Certain claims were found unsearchable** (See Box I).
3.  **Unity of invention is lacking** (see Box II).
4. With regard to the **title**,
  - the text is approved as submitted by the applicant.
  - the text has been established by this Authority to read as follows:  
**ORDER OF TITLES IN A REAL-TIME DVD VIDEO RECORDING**
5. With regard to the **abstract**,
  - the text is approved as submitted by the applicant.
  - the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the **drawings** to be published with the abstract is Figure No.
  - as suggested by the applicant.
  - because the applicant failed to suggest a figure.
  - because this figure better characterizes the invention.

None of the figures.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/05715

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G11B27/034 G11B27/10 G11B27/30 G11B27/32 G11B20/12  
 H04N5/85 //H04N5/775, H04N9/804

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G11B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*&\* document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

23 November 2000

30/11/2000

Name and mailing address of the ISA

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Authorized officer

Daalmans, F

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 00/05715

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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**INTERNATIONAL SEARCH REPORT**

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International Application No.

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(51) International Patent Classification<sup>7</sup>: G11B 27/034, 27/10, 27/30, 27/32, 20/12, H04N 5/85 // 5/775, 9/804

(74) Agent: FAESSEN, Louis, M., H.; Internationaal Octrooibureau B.V., Prof Holstlaan 6, NL-5656 AA Eindhoven (NL).

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- With international search report.
- Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

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99202056.0 ✓ 25 June 1999 (25.06.1999) EP

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(72) Inventor; and  
(75) Inventor/Applicant (*for US only*): DE HAAN, Wiebe [NL/NL]; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).



**WO 01/01415 A1**

(54) Title: ORDER OF TITLES IN A REAL-TIME DVD VIDEO RECORDING

(57) Abstract: A method of recording an encoded bit stream, said encoded bit stream representing a plurality of video objects comprising a sequence of cells together constituting a part of an MPEG2 Program Stream, on a disc like record carrier, such as an optical disc. The method comprises recording a collection of contiguously arranged video objects and management information about recorded video objects. The collection is partitioned into adjacent recordings that represent playable titles, wherein a playable title is defined as a playback sequence of all complete cells or a subset of complete cells of a recording in the order of allocation within the video object storage area on the disc. The method further comprises generating a title list of titles sorted in the order of arrangement within the video object area on the disc. The method defines a free space title that represents free space within the video object area and includes the free space title in the title list.

## ORDER OF TITLES IN A REAL-TIME DVD VIDEO RECORDING

### FIELD OF THE INVENTION

The invention relates to a method for recording encoded information signals as recited in the preamble of claim 1 on a disc like record carrier, such as an optically readable disc. The invention further relates to a recording apparatus for performing the method.

5

### BACKGROUND OF THE INVENTION

The DVD-Video format for optically readable discs is defined in the DVD Specifications for Read-Only Disc, part 3: Video Specifications (version 1.0, August 1996). Relevant parts therefrom are being disclosed in for instance European Patent Application EP 10 724 264 and US Patent 5 784 528, respectively document D1 and D2 in the list of referred documents that can be found at the end of this description. Both documents are incorporated by reference herein.

15 The DVD-Video format as defined in the above mentioned Specifications for READ-Only Disc and disclosed in D1 and D2 was created for storing movies and other video content on read-only DVD media. Some of the features of the DVD-Video format make it less suitable for real-time recording applications.

20 However, it is desirable to create and record video streams and associated data structures on rewritable media in real time which are should preferably be almost identical to the structures defined in the DVD-Video format. Such rewritable discs should be play back compatible with the majority of the installed base of consumer DVD-Video players. The method according to the invention describes a novel and inventive format for DVD-Video compatible real-time recording of video streams, referred to hereinafter to as Real Time DVD Video Recording or shortly DVD-Video Recording. The format defined is intended for home video recording on an optical medium which is playback compatible with DVD-Video 25 players.

The above-mentioned DVD-Video format demands that data for a VTS be allocated contiguously. This gives all kinds of problems when part of the data is overwritten with new recordings:

The DVD-Video format allows an arbitrary numbering of Video Titles (VT) within a Video Title Set (VTS). For instance such as the sequence of Video Titles: VT1, VT3, VT2,..... Overwriting for instance Video Title VT 3 with a new and larger Video Title VT4, will result in overwriting also Video Title VT2. This would appear strange to an user, employing a Video Title menu listing the Video Titles in consecutive order:  
5 VT1, VT2, VT3,..... Such a sequence would be changed into a sequence like: VT1, X, VT4,..... with X denoting a deleted Video Title.

Thus, when partial overwrite is one of the features, the user model of the recording medium becomes complicated.

10

#### OBJECT AND SUMMARY OF THE INVENTION

In consequence, amongst other things, it is an object of the invention to obviate the above-mentioned disadvantages. According to one of its aspects a method of recording to the invention is characterized as recited in the characterizing part of claim 1.

15

By defining the playable items and the list of playable titles in the order of allocation, the recording medium appears to a user as a sequential, tape like medium. The user will understand that when overwriting a specific recording, a subsequent recording may be overwritten too. He would not understand this if the recordings were randomly ordered, as allowed in the DVD Video format, possibly leading to disappearing of a previous recording when overwriting a specific recording.

20

This allows a playback device to employ a simple user model in case of real time DVD video recordings. A title menu, used by a player for display and selection, can simply be read from the management area. There is no need to read the information in the video storage area itself and consequently calculating a title menu. This means that a player adapted for playback of pre-recorded DVD Read-Only discs, does not require modification in order to display a proper title menu.

25

Further advantageous aspects of the invention are recited in other, dependent claims.

#### 30 BRIEF DESCRIPTION OF THE DRAWINGS

These and further aspects and advantages of the invention will be apparent from and elucidated in more detail hereinafter with reference to the disclosure of preferred embodiments, in particular with reference to the appended figures in which,

Fig. 1 illustrates the logical data structure of a DVD disc corresponding to an embodiment for DVD Video Recording according to the invention;

Fig. 2 illustrates more in detail the structure of the Video Manager area (VMG) of Fig. 1;

5 Fig. 3 illustrates more in detail the structure of the Video Title Set Information area (VTSI) of Fig. 1;

Fig. 4 illustrates the structure of the Video Manager Information Management Table (VTSI\_MAT) of Fig. 2;

Fig. 5 illustrates the structure of the Program Chain Information area (PGCI);

10 Fig. 6 shows an example of finding a Titles Program Chain Information (PGCI);

Fig. 7 shows a recording apparatus according to a first embodiment of the invention, the respective units therefrom being illustrated in more detail in the following figures of which

15 Fig. 8 shows an A/V input unit;

Fig. 9 shows a CODEC unit;

Fig. 10 shows an A/V output unit;

Fig. 11 shows a drive unit, and

Fig. 12 shows a system control unit.

## 20 DESCRIPTION OF THE EMBODIMENTS

The data structure to be disclosed hereafter explains the DVD-Video compatibility behind the Real-Time Video Recording Format and specifies how it should be used by recorders to create DVD-Video playback compatible discs.

25 To overcome limitations for real-time recording of the DVD-Video format for read-only discs, a number of changes have been made to the data organization and the use of some of the recording parameters in the real-time data stream.

30 The use of Titles and Menus is restricted to improve exchangeability of rewritable discs between recorders. In addition to this, strict rules are defined for Play Lists, which can be created by the user to define playback sequences of pieces from the recorded Titles.

First a list of definitions is given.

**Access unit**

Coded representation of a presentation unit. See ISO/IEC 13818-1 related to MPEG-2 systems, document D3 in the list of referred documents that can be found at the end of this description, for a more detailed definition of MPEG audio and video access units.

5

**Buffer Cell**

Last Cell of a Video Object (VOB) containing just one Video Object Unit (VOBU). The Buffer Cell is not used by any Program Chain (PCGC). The Cell ID of a Buffer Cell is equal to 255.

10

**Cell**

Sequence of one or more Video Object Units (VOBU). The first VOBU of a Cell shall contain video data. Cells are the basic presentation units for the Program Chains (PGC)

15

**Chapter**

Subdivision of a Title. Other word for Part\_of\_Title (PTT).

**DVD-VR Format**

20

Short for Video Format Specifications for Real-Time DVD-Video Recording.

**DVD-Video format for read-only discs**

25

Format as specified in the DVD specifications for Read-Only Disc- Part 3:

Video Specifications (version 1.0, August 1996), elements of which are being disclosed in

D1 and D2.

**DVD-Video format for rewritable discs**

Format of DVD-Video related structures with the modifications specified in this disclosure.

30

**Elementary stream**

An elementary stream is a generic term for a sequence of coded video, coded audio, coded graphics or other access units that can be correctly decoded by a hypothetical decoder operating without special control from an external controller.

**Free Space**

Recording which is represented by a Free Space Title in the Title Search Pointer Table. If the last Recording is free space, it is not represented in this table.

**5 Free Space Title**

Full Title or Play List Title which cannot be played back as the related Program Chain Information contains a pre-command to prevent this. Time\_Play(), Time\_Search(), PTT\_Play() and PTT\_Search() for a Free Space Title are blocked. The Cell information in the Program Chain of a Free Space Title may not be reliable.

**10 Full Title**

Title representing one Recording.

When a Full Title is played, all complete Cells (except the Buffer Cells) contained in the Recording are played in the order of data allocation in the VTS Title VOBS.

**15 Full Titles may be accessible via the Title Menu.****Group of Pictures (GOP)**

Series of coded pictures starting with a GOP-header followed by an intra coded picture. The GOP represents up to 36 display fields at a rate of 59.94 Hz, or 30 fields at a rate of 50 Hz.

**MPEG-2 Program Stream (MPEG-2 PS)**

Program Stream as defined in ISO/IEC 13818-1 related to MPEG-2 systems, document D3 in the list of referred documents that can be found at the end of this description.

**25****Multiplexed stream**

A multiplexed stream is a single bit-stream, combining one or several elementary streams that can be played in synchronism.

**30 Play List (or Play List Title)**

Title representing a play back sequence of Cells from one Recording. Play Lists are accessible via the Title Menu.

**Program Chain (PGC)**

Playback sequence of Cells for the presentation of a Menu or a Title.

**Real Title**

5 Full Title or Play List Title which is not a Free Space Title.

**Recording**

Contiguous piece of the VTS Title VOBS, enclosing an integer number of MPEG-2 PS packs.

10

The VTS Title VOBS is partitioned into adjacent Recordings which do not necessarily coincide with the VOBs in the VOBS.

**Title**

15 User accessible unit listed in the Title Search Pointer Table.

**Title Menu**

This is a menu that gives the user access to Play Lists and optionally to Full Titles.

20

**Title Search Pointer Table**

Table in the Video Manager listing all available Play Lists and Full Titles on the disc. It is a starting point for finding the data that is relevant for playing back a Title.

25 **Video Manager (VMG)**

DVD-Video data structures containing information about the recorded video data and the Title Menu. The Title Search Pointer Table is one of the elements of the Video Manager.

30 **Video Object (VOB)**

A Video Object is (a part of) a sequence of contiguously recorded Cells, together constituting (a part of) an MPEG-2 Program Stream.

An integer number of MPEG-2 Program Stream packs may be missing from the beginning of the first Cell of the VOB, if this Cell is not used by any Title. The last Cell of a VOB is a Buffer Cell.

5 A VOB shall contain one video elementary stream. Gaps in the video stream are allowed under conditions specified by the DVD-Video specifications.

10 According to the DVD-Video specifications a VOB may also contain up to eight Audio streams (in elementary audio streams and/or in private streams) and up to 32 Sub-picture streams. The DVD-VR format only allows one Audio stream and one Sub-picture stream within the same VOB.

#### **Video Object Unit (VOBU)**

15 Integer number of MPEG-2 Program Stream packs representing a presentation period between 0.4 and 1.0 seconds.

The last VOBU of a Cell has a maximum presentation period of 1.2 seconds. When the VOBU contains Video, the video data consists of an integer number of GOPs and starts with a sequence header, a GOP header and an intra coded picture.

20 A Sub-picture Unit is optional in a VOBU and cannot cross VOBU boundaries. The SPU's associated validity period ends at or before the end presentation time of the VOBU.

#### **25 Video Object Set (VOBS)**

This is a collection of contiguously recorded VOBs.

VOBs which are used for the menus are stored in the Video Manager VOBS (VMGM\_VOBS). VOBs which are used for the Titles are stored in the VTS Title VOBS (VTSTT\_VOBS).

Fig.1 shows the general data structure in accordance with the Real-Time Video Recording format. The data structure comprises a Lead-In area (LI), a Volume (VOL) and File System area (FS), a Video Manager area (VMG), one Video Title Set (VTS), an area

reserved for other structures (OTHER) and a Lead-Out area (LO) as known from the DVD-ROM data structure. Not specifically shown in Fig. 1 is Presentation Control Information (PCI) and Data Search Information (DSI) within the Video Object Set for VTS Titles (VTSTT\_VOBS), both dispersed in the Navigation Packs (NV\_PCK) of each Video Object Unit (VOBU).

The data organization according to the Real-Time Video Recording format will first be discussed in general.

With respect to the Video Manager (VMG) the following is remarked. The Video Manager (VMG) shall contain a Title Menu. Consequently a Video Object Set for Video Manager Menu (VMGM\_VOBS) is mandatory.

With respect to the Video Title Sets (VTS) the following is remarked. The data structure on a disc contains only one Video Title Set (VTS). The Root Menu shall contain a dummy Program Chain (PGC) with a pre-command calling the Title Menu. No other Video Title Set (VTS) menus shall be present on the disc. Consequently the Video Title Set (VTS) does not contain a Video Object Set for a Video Title Set Menu (VTSM\_VOBS). The Video Object Set for Video Title Set Titles (VTSTT\_VOBS) of the Video Title Set (VTS) contains the recorded video content.

With respect to the Video Object Set (VOBS), the Video Objects (VOBs) and Cells, the following is remarked. A Video Object (VOB) is (a part of) a sequence of contiguously recorded Cells, together constituting (a part of) an MPEG-2 Program Stream as defined in D4. An integer number of MPEG-2 Program Stream packs may be missing from the beginning of the first Cell of the Video Object (VOB), if this Cell is not used by any Title. The last Cell of a Video Object (VOB) is a Buffer Cell, which is not used by any Title.. A Video Object Set (VOBS) is a collection of contiguously recorded Video Objects (VOBs). Video Objects (VOBs) and Cells on a rewritable disc are not fully compliant with the Video Specifications for the DVD Read-Only Disc as disclosed in D2 and D4. The following exceptions are allowed or required:

- 1) The DVD-Video specification demands that a Video Object (VOB) starts with an System Clock Reference (SCR) equal to zero. This is not required for DVD-VR discs.
- 2) The Display of the video stream from one Video Object (VOB) does not have to start with a top field nor have to end with a bottom field.
- 3) The DVD-Video specification prescribes incremental numbering of Video Objects (VOBs) and Cells. When recording the disc for the first time that requirement can generally be met. However, when old recordings are (partly) overwritten, or when the

user does editing, it may not be possible to maintain the incremental numbering. To overcome this problem, DVD-VR format requires that the Video Object Identification number (VOB ID) of all Video Object (VOBs) is equal to '1'. In addition to this, Cell ID numbers (except number 255) remain unique but they are allowed to be non sequential.

5      4) Video Objects (VOBs) and Cells contain Navigation packs (NV\_PCK) with forward references to facilitate forward search. Some of these forward references cannot be known at recording time and therefore must be encoded with values that make legacy playback devices behave in an acceptable way.

5) The Navigation packs (NV\_PCK) also contain a parameter specifying the presentation 10 termination time of the last video frame of the Video Object (VOB). This parameter cannot be made correct in real time in all cases. To solve this problem a high number will be recorded for this parameter. A Buffer Cell at the end of a Video Object (VOB) guarantees that the end of a Video Object (VOB) is never reached during play back.

15            With respect to recordings, the following is remarked:

The Video Object Set for Titles in a Video Title Set (VTSTT\_VOBS) can be partitioned into a collection of adjacent pieces, called Recordings, which do not necessarily coincide with the Video Objects (VOBs). Recordings enclose an integer number of MPEG-2 PS packs.

20            Recordings relate to the partitioning of the content as it is presented to the user.

With respect to Full Titles, Play Lists and Free Space, the following is remarked:

25            For each Recording two One\_Sequential\_PGC\_Titles are created: one Full Title and one Play List. The Full Title defines play back of all complete Cells (except Buffer Cells) of a Recording in the order of allocation in the Video Object Set (VOBS). The Play List may be different from the Full Title. If so it defines play back of a subset of the Cells which are played by the Full Title.

30            Full Titles and Play Lists are each represented as a Title in the Title Search Pointer Table in VMGI (TT\_SRPT) and as a Title Unit (TTU) in the Part\_of\_Title Search Pointer Table in the VTSI (VTS\_PTT\_SRPT). A Play List points to the same Program Chain (PGC) as the corresponding Full Title, unless a different Program Chain (PGC) is recorded for the Play List.

Full Titles and Play List Titles are Real Titles, unless they are tagged as Free Space. When a Full Title is deleted by the user, both the Full Title and the Play List in the Title Search Pointer Table (TT\_SRPT) are tagged as Free Space by setting a unique Playback Type value (TT\_PB\_TY). If two consecutive Full Titles are deleted, the entries in  
5 the Title Search Pointer Table (TT\_SRPT) shall be combined into one new Title. Also the related Play Lists are combined and tagged as Free Space. Free space that is available on the disc at the end of the VTS Title VOBS or beyond the boundaries of the VTS, is not reflected in the TT\_SRPT. Fig. 6 illustrates an example of finding a Title's PGCI.

Within Fig. 6 the following data structures are given: Title Play Back Type  
10 (TT\_PB-TY), Number of Part\_of\_Title (PTT\_Ns), VTS Title Number (VTS\_TTN), PGC\_Number (PGCN), Program Number (PGN), Start Address of VTS Program Chain Information Table (VTS\_PGCI-SA), Program Chain Information Table (PGCIT), Number of Angles (AGL-Ns), Parent\_ID\_field for Title (TT\_PTL\_ID-FLD), VTS Number (VTSN) and Parent ID-field (PTL\_ID\_FLD).

15 Each Title (except for the last Play List Title and the last Full Title) is linked to the next Title by a LinkPGCN instruction in the associated Program Chain Information (PGCI). The Program Chain Information (PGCI) of the last Play List and the last Full Title contains a CallSS to the Title Menu. If the Title is tagged as Free Space, this instruction is stored as a pre-command in the Program Chain Information (PGCI). Otherwise the  
20 instruction is stored as a post-command.

The number of Full Titles on a DVD-VR disc is equal to the number of Play Lists with a maximum of 49. Titles can be sub-divided into a maximum of 99 Chapters (Part\_of\_Titles). The maximum number of Chapters for all Full Titles on one disc is 254.

In the following the restrictions and modifications compared to the read-only  
25 format will be given.

As already disclosed with reference to Fig. 1, exactly one Video Title Set is recorded on disc. Fig. 2 illustrates the data structure of Video Manager General Information (VMGI) within the Video Manager (VMG) area as shown in Fig.1. As in Fig.1, the Presentation Control Information (PCI) and Data Search Information (DSI) are not shown in  
30 Fig2, although this information is dispersed in corresponding Navigation Packs (NV\_PCK) in each Video Object Unit (VOBU) of the Video Object Set for the Video Manager Menu (VMGM\_VOBS).

With respect to the Video Manager Information Management Table (VMGI\_MAT), the first 8 bytes of the Provider Unique ID (PVR\_ID) contains the string

'DVD-VR01'. The First Play Program Chain (FP\_PGC) contains just a JumpSS to the Title Menu as a pre-command.

The Title Search Pointer Table (TT\_SRPT) consists of two sections of equal length. The first half contains pointers for N Play Lists and the second half contains pointers to N Full Titles. Play Lists as well as Full Titles are sorted in the order of incrementing start addresses of the first used Cell in the Video Object Set (VOBS). All Titles are One\_Sequential\_PGC\_Titles for which Time\_Play() and Time\_Search() are blocked. Part\_of\_Title\_Play() and Part\_of\_Title\_Search() shall be blocked for Titles which are associated with Free Space and shall not be blocked for other Titles. Table 1 lists allowed Playback Types as indicated by the Title\_Playback\_Type (TT\_PB\_TY) field.

Table 1 Allowed values of TT\_PB\_TY

<b>Value of TT_PB_TY</b>	<b>Type of Title</b>
0000 0101b	Real Title which is not the last Play List or not the last Full Title
0001 0101b	Real Title which is the last Play List or the last Full Title
0000 0111b	Free Space Title

#### The Video Manager Menu Program Chain Information Unit Table

(VMGM\_PGCI\_UT) is just linked to the Title Menu. There shall be only one Language Unit. The Video Manager Menu exists in this Language Unit.

Following the Video Title Set Attribute Table (VTS\_ATRT), the Video Manager Menu Cell Address Table (VMGM\_C\_ADT) is restricted to a maximum of 170 cells and the Video Manager Menu Video Object Unit Address Map (VMGM\_VOBU\_ADMAP) to a maximum of 511 VOBUs. The remaining part of the Video Manager area (VMG) is occupied with the Video Manager Menu Video Object Set (VMGM\_VOBS) and the back up of the Video Manager Information (VMGI\_BUP).

With reference to Fig. 3, the Video Title Set Information (VTSI) will be discussed. As the Root Menu contains just a dummy Program Chain (PGC) and other menus are not allowed, the Video Title Set (VTS) Menus have no associated Video Object (VOB) data. Consequently the Cell Address Table of the Video Title Set Menu (VTSM\_C\_ADT) and the Address Map of the Video Object Unit of the Video Title Set (VTSM\_VOBU\_ADMAP) do not exist.

The Management Table of the Video Title Set Information (VTSI\_MAT) comprises the following area (not shown in the figure):

- the VTS Video Attributes (VTS\_V\_ATR) (the video compression mode complies with MPEG-2),
- 5 - the number of Audio Streams (VTS\_AST\_Ns) describing the number of different audio stream attribute sets used in this VTS,
- the VTS Audio Stream Attribute Table (VTS\_AST\_ATRT) listing the different audio stream attribute sets which are defined (and may or may not be used) for this VTS. The PGCI for each Title defines which of the sets is actually used,
- 10 - the number of Sub-picture Streams (VTS\_SPST\_Ns) (set to one in this VTS) and
- the VTS Sub-picture Stream Attribute Table (VTS\_SPST\_ATRT) (all fields in this table are zero)

The Video Title Set Information (VTSI) further comprises further a Video Title Set Part\_of\_Title Search Pointer Table (VTS\_PTT\_SRPT) wherein the Title Units are recorded in the same order as Titles in Title Search Pointer (TT\_SRPT).

Next is present a Video Title Set Program Chain Information Table (VTS\_PGCIT). The number of Video Title Set Program Chain Information (VTS\_PGCI) search pointers is equal to the number of Titles in Title Search Pointer Table (TT\_SRPT). The search pointers are recorded in the same order as the Titles. All Program Chains (PGCs) are Entry PGCs with all bits zero for Block mode, Block type and Parental ID Field (PTL\_ID\_FLD). When a Play List is equal to the associated Full Title, their Start Address of Video Title Set Program Chain Information (VTS\_PGCI\_SA) values are identical.

With respect to the Video Title Set Menu Program Chain Information Unit Table (VTSM\_PGCI\_UT) the following is remarked. The number of Video Title Set Menu Language Units as specified in VTSM\_PGCI\_UTI shall be 1. There is exactly one Video Title Set Menu Language Unit Search Pointer (VTSM\_LU\_SRP). The Video Title Set Menu Existence field (VTSM\_EXST) shall contain the value (1000 0000b) to indicate that just the Root Menu exists. The Video Title Set Menu Language Unit (VTSM\_LU) contains just one Program Chain Information Search Pointer (VTSM\_PGCI\_SRP). The Video Title Set Menu Program Chain Category parameter (VTSM\_PGC\_CAT) for the Video Title Set Menu Program Chain (VTSM\_PGC) contains the value (8300 0000h) indicating that the associated Program Chain (PGC) is the Entry PGC for the Root Menu. There is exactly one Video Title Set Menu Program Chain Information (VTSM\_PGCI).

The Video Title Set Time Map Table (VTS\_TMAPT) contains Video Title Set Time Maps (VTS\_TMAPs) that are present for all Titles on the disc but do not contain any map entries.

With respect the Video Title Set Cell Address Table (VTS\_C\_ADT), the parameter  
5 containing the number of Video Object in the Video Title Set (VTS\_VOB\_Ns) contains the  
contains the value '1'. It is noted that the VTS\_VOB\_Ns does not reflect the actual number  
of VOBs in the Video Object Set of a rewritable disc. It is set to 1 as the VOB ID number of  
all VOBs is set to '1'. All Video Title Set Cell Piece Information (VTS\_CPI) have the same  
value ('1') for the Video Title Set Video Object ID Number (VTS\_VOB\_IDN). Exactly 254  
10 VTS\_CPI blocks are recorded with VTS\_C\_IDN starting from '1' and incrementing up to  
and including '254'. The Start Address and End Address of the Video Title Set Cell Piece  
(VTS\_CP\_SA and VTS\_CP\_EA) of Cell Pieces which are not referenced by any PGC of a  
Real Title contain the value (0000 0000h). It is noted that Cell Pieces that are referenced by a  
PGC of a Free Space Title contain zero start and end addresses.

15 With respect to The Video Title Set Video Object Unit Address Map  
(VTS\_VOBU ADMAP) it is remarked that all Video Object Unit (VOBU) start addresses of  
the VOBUs which are completely contained in VTSTT\_VOBS are listed here in ascending  
order. It is noted that VOBU start addresses of VOBUs which are part of Free Space are  
also included in the VTS VOBU Address Map.

20 Next the structure of the Program Chain Information area (PGCI) for Title  
Program Chains will be given with reference to Fig. 5. This structure comprises a Program  
Chain General Information Area (PGC-GI), a Program Chain Command Table  
(PGC\_CMDT), a Cell Playback Information Table (C\_PBIT) and a Cell Position Information  
Table (C\_POSIT).

25 With respect to the Program Chain General Information (PGC-GI) it is noted  
that exactly one of the Availability flags in the Program Chain Audio Stream Control Table  
(PGC\_AST\_CTLT) is set to (1b). When the  $i^{th}$  Availability flag is set, the  $i^{th}$  Audio stream  
parameter set defined for this Video Title Set (VTS) is valid for this Program Chain (PGC).  
The Decoding Audio stream number is always '0'.

30 The availability flag of the first Program Chain Sub-picture Stream Control  
(PGC\_SPST\_CTL) field in the Program Sub-picture Stream Control Table  
(PGC\_SPST\_CTLT) is set to (1b). All other bits of the Program Sub-picture Stream Control  
Table (PGC\_SPST\_CTLT) contain the value (0b).

The Program (PG) Playback mode in the Program Chain Navigation Control (PGC\_NV\_CTL) is set to sequential playback. The Still time value is set to no Still.

The PGC Command Table (PGC-CMDT) contains exactly three commands. According to this version of the specification only one command is actually used (for Title linking), the other two commands are NOP commands (0000 0000h). Which command is used for Title linking is defined in Table 2.

Table 2 Commands in PGCI

PGC associated with ...	contains ...	as a ...
Real Title which is not the last Play List or not the last Full Title in TT_SRPT	LinkPGCN to PGC of next Real Title	post-command
Real Title which is the last Play List or the last Full Title in TT_SRPT	CallSS to Title Menu	post-command
Free Space Title	LinkPGCN to PGC of next Real Title	pre-command

10

With respect to Cell Playback Information Table (C\_PBIT): Cells are not part of an Angle Block and do not exist in an Interleaved Block.

With respect to the Cell Position Information Table (C\_POSIT): the Identification Numbers of the Video Objects of all Cells in the PGC contain the value '1'. It is noted that, on DVD-VR discs, all VOBs have the same VOB\_IDN.

It is allowed that the Cell ID number of a Cell of which the Seamless playback flag set in Cell Playback Information, is not the same as the previous Cell ID number incremented by 1.

With respect to the Presentation Control Information (PCI) it is noted that modifying a Play List may require that a Cell is split into two new Cells. In that case all values of Cell Elapse Time (C\_ELTM in PCI\_GI) shall be updated in all PCI fields in the second Cell.

Additional data fields with respect to the DVD-Video format for Read-Only discs for carrying real-time stream attributes are given below.

The last reserved 32 bytes of the General Information of Presentation Control Information (PCI\_GI) are redefined in this specification as shown in table 3

Table 3 Redefinition of reserved fields at end of PCI\_GI

	Contents	Number of bytes
Reserved	Reserved	16 bytes
(8) PCI_GI_XI	PCI_GI Extension Information	1 byte
(9) RT_V_ATR	Video Attributes	1 byte
(10) RT_AST_ATR	Audio Stream Attributes	1 byte
Reserved	Reserved	13 bytes
	Total	32 bytes

PCI\_GI\_XI identifies the application and specifies the length of the extension.

5 If all bits in this byte are zero, also the bytes of PCI\_GI following this field are zero:

b7	b6	b5	b4	b3	b2	b1	b0
Application Identifier	Extension Length						

Application Identifier contains the value (0001b) if the stream attributes as

defined in VTSI\_MAT for this VTS must be overruled by the real-time stream attributes.

10 Otherwise contains the value (0000b). The real-time stream attributes are valid from Start PTM until End PTM of the VOBU in which this field is contained.

Extension Length defines the number of bytes for this extension following this

field. It shall contain the value (0010b) if Application Identifier is (0001b). It contains the

15 value (0000b) if Application Identifier is (0000b).

RT\_V\_ATR describes the real-time Video stream attributes.

b7	b6	b5	b4	b3	b2	b1	b0
Aspect ratio	Reserved		reserved	Source picture letter boxed	reserved	Film camera mode	

Aspect ratio, Source picture letterboxed and Film camera mode have meanings as defined in the DVD specifications for the Read\_Only Disc.

RS\_AST\_ATR describes the real-time Audio stream attributes:

b7	b6	b5	b4	b3	b2	b1	b0
reserved	Surround Type			reserved			

5

Surround Type as defined in the DVD Specifications of the Read-Only Disc. With respect to Data Search Information (DSI) it is noted that all VOBs are allocated in Contiguous Blocks and there are no Angles.

With respect to the Data Search Information General Information (DSI\_GI) it  
10 is remarked that the Video Object ID number (VOB ID) number is always 1. Further there is no requirement that the Cell ID numbers are monotonically increasing from 1 in the Video Object. The following rules shall be applied for Cell ID:

- Cell ID is identical in all VOBUs belonging to the same Cell
- Cells which are used by Real Titles are uniquely identified by their Cell ID

15 It is noted that modifying a Play List may require that a Cell is split into two new Cells. In that case all values of Cell Elapse Time (C\_ELT in DSI\_GI) shall be updated in all DSI fields in the second Cell.

With respect to Video Object, it is remarked that an integer number of MPEG-  
2 Program Stream packs may be missing from the beginning of the first Cell of the VOB, if  
20 this Cell is not used by any Title. The last Cell of a VOB is a Buffer Cell.

It is noted that seamless connections between VOBs are excluded.

Only one Audio stream is allowed within a VOB. The Audio decoding stream number is '0'.

Only one Sub-picture stream is allowed within a VOB. The Sub-picture decoding stream number is '0'. Data for a Sub-picture Unit (SPU) is fully contained in one VOBU. The SPU validity period shall not start before the Start PTM of the VOBU, nor shall it end later than the End PTM of the VOBU.

The DVD-Video format for rewritable discs is not fully identical to the DVD-  
Video format for read-only discs. The differences are (1) in the rules for data allocation and  
30 (2) in some details of the navigation data in the real-time data streams. The first kind of differences generally has no consequences for DVD-Video players. As a consequence of the second kind of differences in some cases trick mode behavior of DVD-Video playback

devices with rewritable discs may not be always exactly the same as with prerecorded discs. Manufacturers can improve compatibility between DVD-Video players and rewritable discs by following the guidelines given in the next.

With respect to VOBS Structures; on rewritable DVD-Video discs some rules

5 for the Video Object Set data structures are different from the rules for read-only discs.

DVD-Video players will play back rewritable discs well when they are robust against:

- non-sequential numbering of VOBs in the VTSTT\_VOBS
- non-sequential numbering of Cells within a VOB
- the existence of remnants of partly overwritten Cells or other unused data in between  
10 "active" Cells
- modified rules for forward search pointers as defined next :

DVD-Video recorders are required to at least fill in correct forward pointers FWDI(n) for  $n \leq M$ . Forward pointers FWDI(n) with  $M < n \leq N$  contain the last correct value. For  $n > N$  forward pointers point to the end of the current Cell. The duration of a Cell on a rewritable  
15 disc is typically 60 seconds.

This means that for forward search functionality DVD-Video players can still rely on the FWDI pointers for the lower speeds (2x, 4x, 8x). For higher speeds, the player can still use the long distance FWDI pointers but in this case they point to the end of the current Cell. If accurate fast search speeds are desired, the speed can be adjusted by picking up  
20 intermediate pictures (e.g. by applying a FWDI(6) pointer) or by adapting the display period of the pictures.

Fig. 7 shows a recording apparatus according to a first embodiment of the invention. The recording apparatus is composed of several units. One unit is the A/V input unit 1. The A/V input unit 1 receives image and sound signals at antenna input terminal 2 and  
25 an external sound/image input terminal 3. The antenna input terminal 2 is adapted to receive broadcasted modulated A/V signals transmitted by either satellite, terrestrial or cable source. The external sound/image input terminal 3 is adapted to receive a non modulated audio signal or a non-modulated video signals generated directly by respectively an audio or a video source.

30 Fig. 8 illustrates the A/V input unit 1 in more detail. A tuner 5 , which is connected to the antenna input terminal 2, demodulates the modulated A/V antenna signals and outputs the demodulated signals to a suitable A/V demultiplexing unit 6 for separating audio signals from video signals . An audio A/D converter unit 7 outputs a digital audio signal A and a NTSC/PAL/SECAM decoding unit 8 , comprising a video A/D converter,

outputs a digital video signal V. These signals A and V are outputted to a encoding/decoding unit 9, which is illustrated in more detail in Fig. 9. The encoding/decoding unit 9 compresses and encodes the signals A and V, respectively by an audio encoder 10 and a video encoder 11, converts them to a multiplexed and compressed stream conforming to Video Recording specifications, employing a multiplexer 12. To this purposes the audio encoder 10 and video encoder 11 are adapted to perform source compression according to a specific standard for compression, such as for example MPEG-2 for audio and video.

The compressed and multiplexed stream is submitted via a track buffer 13, which absorbs rate fluctuations stemming from intermittent recording and data reproduction from a disc, to a drive unit 14. The encoding/and decoding unit 9 also expands a compressed stream read from a recording medium by the drive unit 14 and outputs separately an audio signal A and a video signal V to the A/V output unit 15. To this purpose, the encoding/decoding unit 9 comprises a suitable A/V decoder 16 for decoding the compressed audio and video source signals.

The A/V output unit 15, which is illustrated in more detail in Fig. 10, comprises an audio D/A converter 17 for outputting sound signals to an external sound output terminal 18. The A/V output unit 15 further comprises a video encoder - D/A converter unit 19 for outputting video signals to an external image output terminal 20.

Fig. 12 illustrates the drive unit 14 in more detail. This unit 14 receives the compressed stream generated by the encoding/decoding unit 9, and adds an error-correction code by a suitable error correction processing unit 21 to the stream. Next a channel modulation/demodulation unit 22 converts the stream with error-correction code to channel bits adapted for recording on a recording medium 23. In case of a DVD-disc the EFM+ modulation scheme is being applied. Recording and reading in case of a recording medium 23 of the optical type, is performed by a laser comprised in an optical head unit 25. A laser power control unit 24 is controlling the laser. Reflected signals from the recording medium 23 are being converted by an amplifier and waveform equalizer circuit 26 into two-value signals. The resultant compressed stream is further demodulated by the modulating/demodulation unit 22 , error corrected by the error correction processing unit 21 and outputted to the encoding/decoding unit 9 via track buffer 13.

A servo circuit 27, connected to the amplifier and waveform equalizer circuit 26, controls the positioning of the optical head unit 25 relative to the recording medium 23 and the rotational velocity of the recording medium 23 by controlling rotational driving means 28.

A system control unit 29 controls each block and perform file control, control information management and track buffer control. To this purpose a system control processing unit 30 is provided that is being connected to memory means 31 loaded with a suitable operation system. Operator input means 32 and operator output means 33 are  
5 connected to the memory means 31. The operator input means 32 comprising for instance keying means and the operator output means comprising display means.

Although the invention has been described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus, various modifications thereof may become apparent to those skilled in the art, without  
10 departing from the scope of the invention, as defined by the claims. The invention can be implemented by means of both hardware and software, and that several "means" may be represented by the same item of hardware. Further, the invention lies in each and every novel feature or combination of features. It is also remarked that the word 'comprising' does not exclude the presence of other elements or steps than those listed in a claim. Any reference  
15 signs do not limit the scope of the claims.

#### LIST OF REFERRED DOCUMENTS

(D1) European Patent Application EP 724 264

20 (D2) US Patent 5 784 528

(D3) ISO/IEC 13818-1 : 1995 Information Technology – Generic Coding of moving pictures and associated audio information : Part 1 : Systems (MPEG2-systems)

## CLAIMS:

1. A method of recording an encoded bit stream, said encoded bit stream representing a plurality of video objects comprising a sequence of cells together constituting a part of an MPEG2 Program Stream, on a disc like record carrier, such as an optical disc, said method comprising:

5 recording a collection of contiguously arranged video objects in a video object storage area of said disc,

recording management information in a management information area of said disc for storing information about recorded video objects, wherein

said collection is partitioned into adjacent recordings that represent playable

10 titles,

characterized by,

defining a playable title as a playback sequence of all complete cells or a subset of complete cells of a recording in the order of allocation within the video object storage area on the disc, and

15 generating a title list of titles sorted in the order of arrangement within the video object area on the disc.

2. A method according to claim 1, characterized by defining a free space title that represent free space within the video object area and including the free space title in the title

20 list.

3. A method according to claim 2, characterized by blocking free space titles for playback.

25 4. A method according to claim 3, characterized by converting a deleted title to a free space title.

5. A method according to claim 4, characterized by generating a title menu listing the titles in the same order as in the title table for allowing user access to the titles.

6. A recording apparatus for recording an encoded bit stream, representing a plurality of video objects comprising a sequence of cells together constituting a part of an MPEG2 Program Stream, on a disc like record carrier, such as an optical disc, the recording apparatus comprises

5 recording means for recording a collection of contiguously arranged video objects in a video object storage area of said disc and for recording management information in a management information area of said disc for storing information about recorded video objects, wherein said collection is partitioned into adjacent recordings that represent playable titles,

10 characterized in that, the recording apparatus comprises  
system control means adapted to define a playable title as a playback sequence of all complete cells or a subset of complete cells of a recording in the order of allocation within the video object storage area on the disc and to generate a title list of titles sorted in the order of arrangement within the video object area on the disc.

15 7. A recording apparatus according to claim 6, characterized in that, the system control means are adapted to define a free space title that represents free space within the video object area and including the free space title in the title list.

20 8. A recording apparatus according to claim 7, characterized in that, the system control means are adapted to block free space titles for playback.

9. A recording apparatus according to claim 8, characterized in that, the system control means are adapted to convert a deleted title to a free space title.

25 10. A recording apparatus according to claim 9, characterized in that, the system control means are adapted to generate a title menu listing the titles in the same order as in the title table for allowing user access to the titles and the recording means comprises output means for displaying the title menu.

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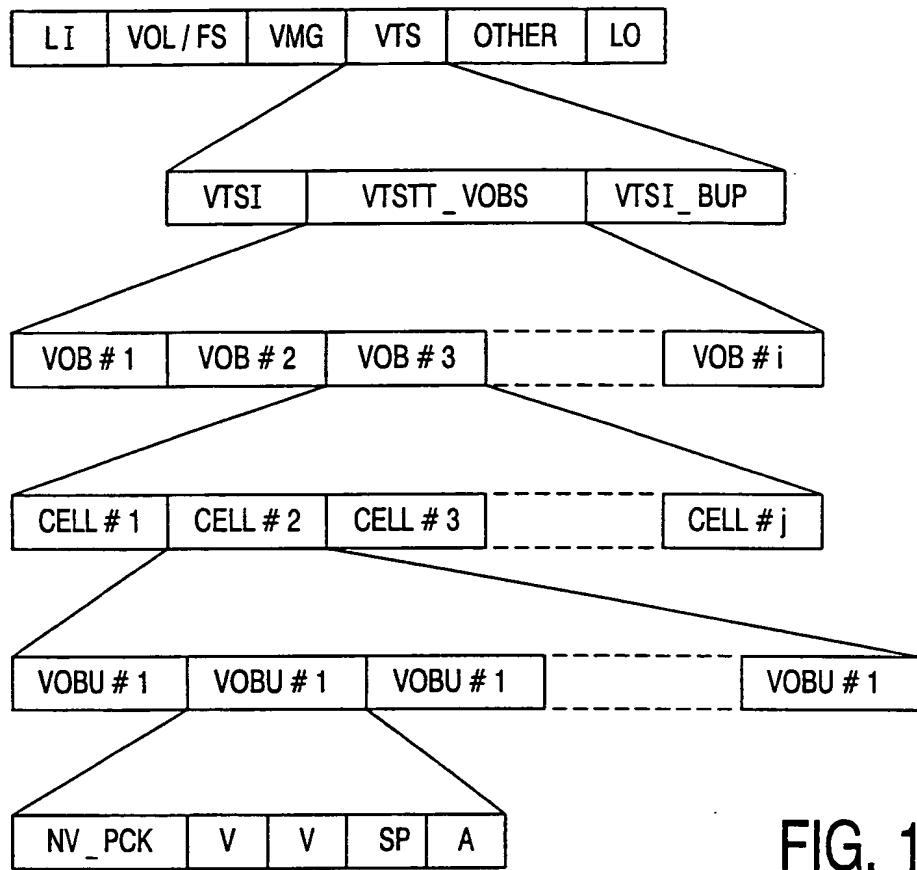


FIG. 1

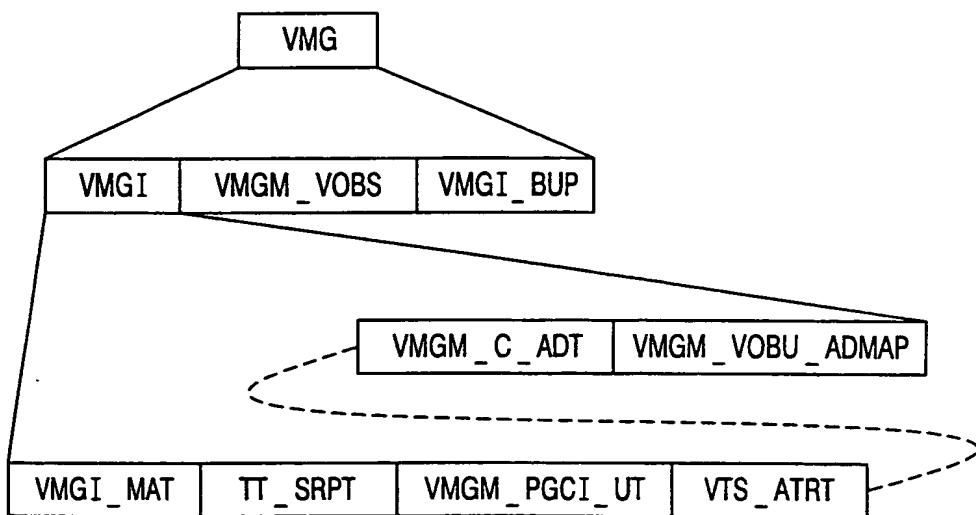


FIG. 2

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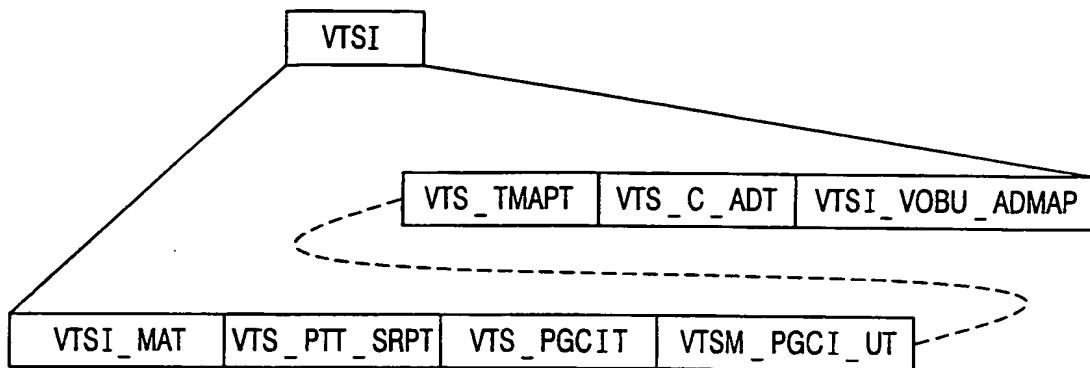


FIG. 3

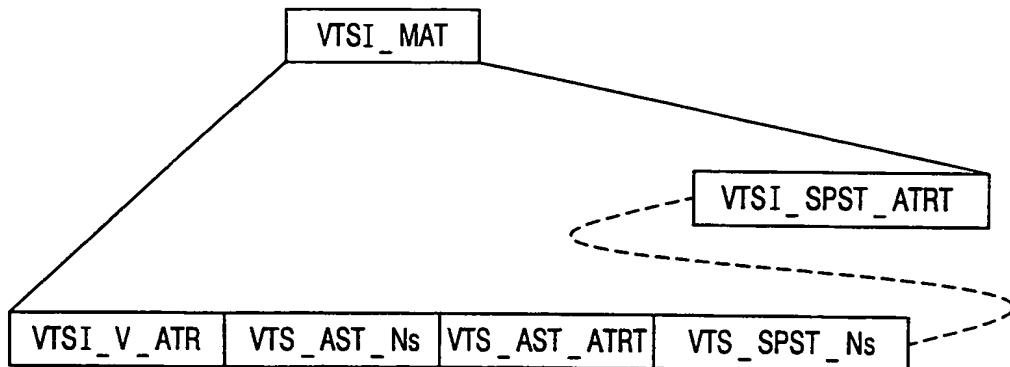


FIG. 4

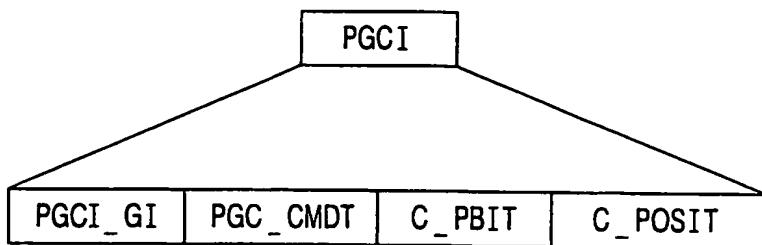


FIG. 5

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	VMGI / TT_SRPT / TT_SRPs			VTSI / VTS_PTT_S
EXAMPLE	TT_PB_TY	PTT_Ns	VTS_TTN	
PLAY LIST 1	0000 01x1		1	1
PLAY LIST 2			2	2
			..	..
AS ORIGINAL I	0000 0101	4	I	1
			..	2
PLAY LIST K	0000 0101	3	K	3
			..	4
FREE SPACE	0000 0111	1	M	5
			..	6
PLAY LIST N	0001 01x1		N (< 50)	
ORIGINALS	ORIGINAL 1	0000 01x1	N + 1	
	ORIGINAL 2		N + 2	
			..	
	ORIGINAL I	0000 0101	4	4
			..	5
	ORIGINAL K	0000 0101	5	5
			..	6
	FREE SPACE	0000 0111	1	
			..	
	ORIGINAL N	0000 01x1	N + N	

AGL\_Ns == '1'

TT\_PTL\_ID\_FLD == zero

VTSN == '1'

Bit 1 of TT\_PB\_TY indicates free space

FIG. 6A

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VTSI / VTS _ PTT _ SRPT / TTUs	
PGCN	PGN
1	1
	..
2	1
..	..
I	1
	2
	3
	4
K	1
	2
	3
M	1
N	1
N	..
N + 1	1
	..
N + 2	1
..	..
N + I	1
	2
	3
	4
N + K	1
	2
	3
	4
N + M	1
N + N	1
	..

The diagram illustrates the mapping of row numbers from the left side to the corresponding entries in the table. Arrows point from numbered circles (1 through 12) to specific rows:

- Arrow 1 points to row 1 (PGCN 1).
- Arrow 2 points to row 2 (PGCN 2).
- Arrow 3 points to row M.
- Arrow 4 points to row N+I.
- Arrow 5 points to row N+K.
- Arrow 6 points to row N+N.
- Arrows 7, 8, 9, 10, 11, and 12 point to the rightmost column of the table, specifically to the PGN values 1, 2, 3, 4, 1, 2, 3, 1, 2, 3, 4, and 1 respectively.

FIG. 6B

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VTSI/VTS_PGCIT/VTS_PGC I_SRPs	
VTS_TTN	VTS_PGC I_SA
1	
2	
..	
7	I → ORIGINAL I PGCI
8	..
K	→ PLAY LIST K PGCI
..	
9	M → FREE SPACE M PGCI
..	
N	
N + 1	→ ORIGINAL 1 PGCI
N + 2	→ ORIGINAL 2 PGCI
..	
10	N + I → ORIGINAL I PGCI
..	
11	N + K → ORIGINAL K PGCI
..	
12	N + M → FREE SPACE M PGCI
..	
N + N	→ ORIGINAL N PGCI

Entry type == 1  
 Block mode == 00b  
 Block type == 00b  
 PTL\_ID\_FLD == 0000h

Equal VTS\_PGC I\_SA indicate "no THL"

FIG. 6C

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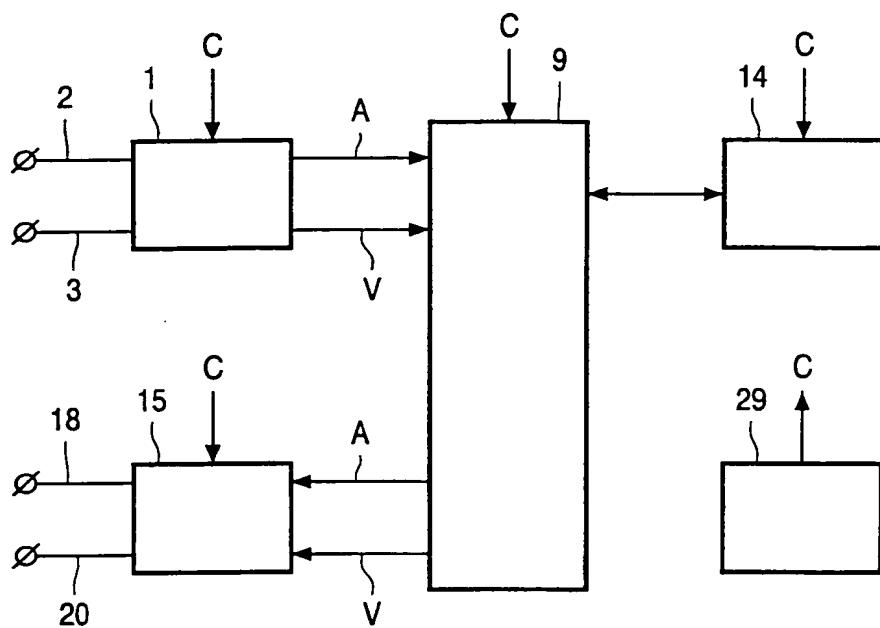


FIG. 7

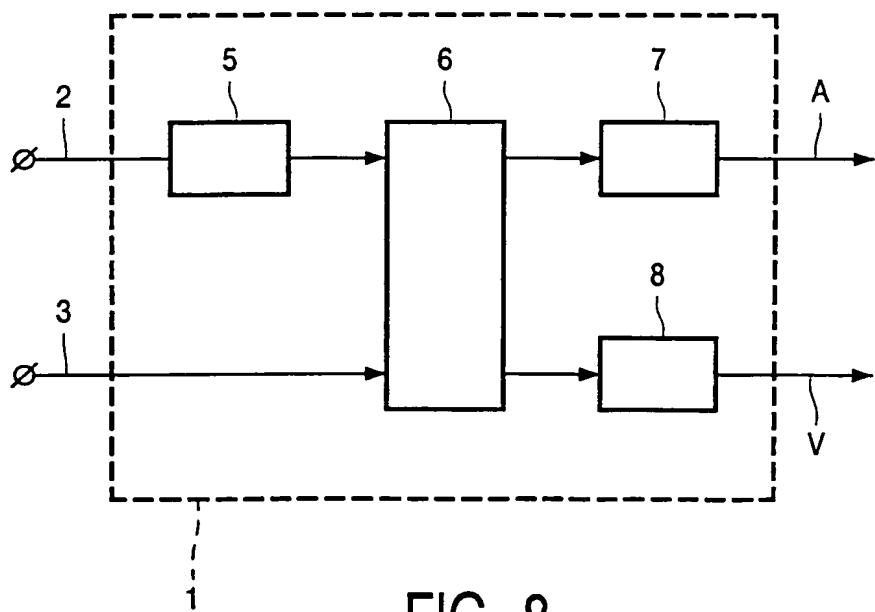


FIG. 8

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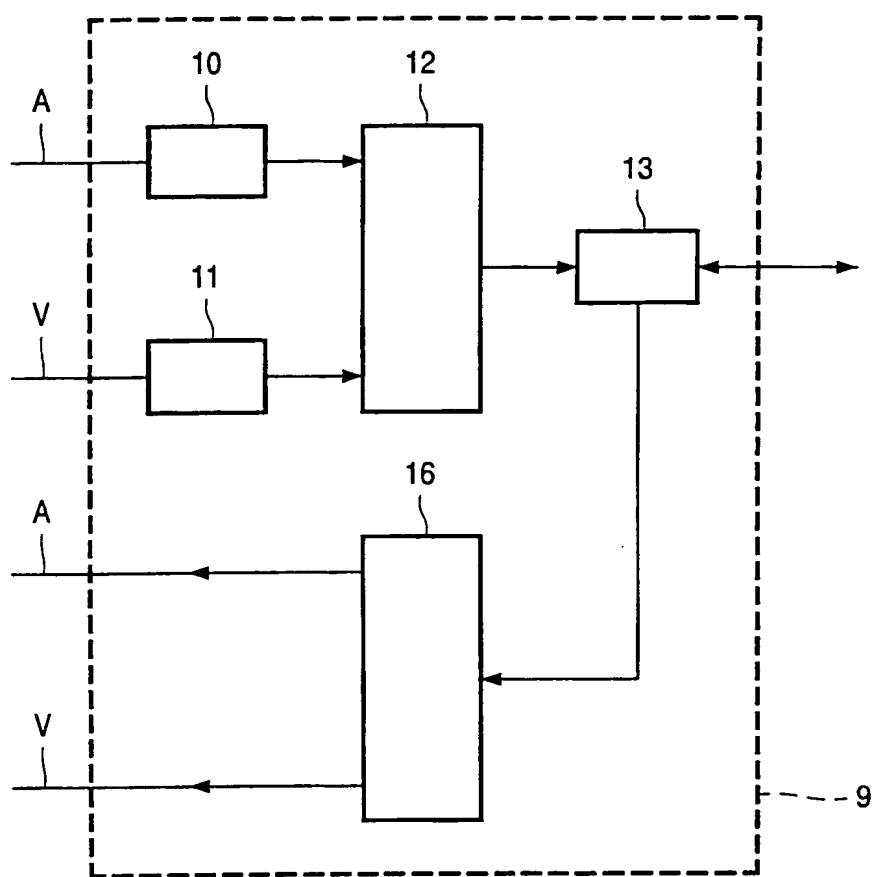


FIG. 9

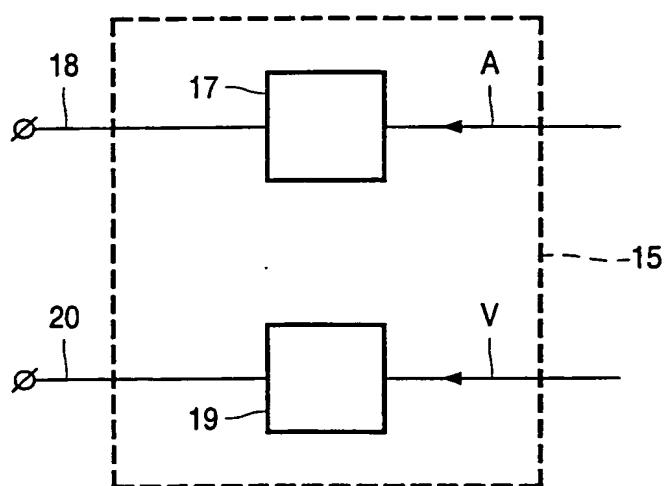


FIG. 10

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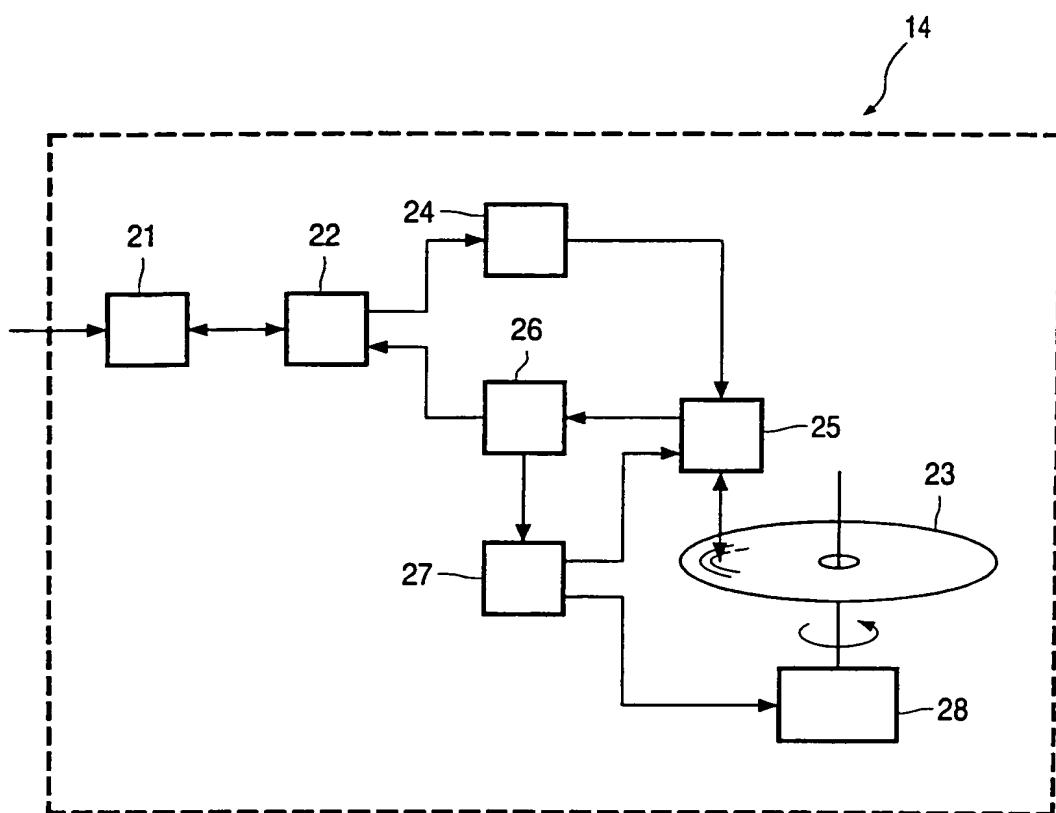


FIG. 11

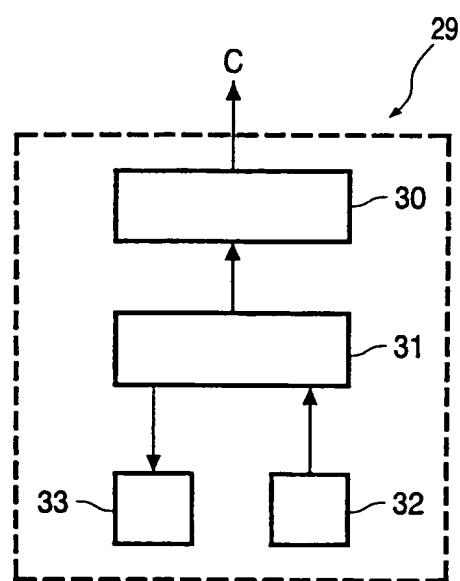


FIG. 12

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/05715

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 G11B27/034 G11B27/10 G11B27/30 G11B27/32 G11B20/12  
 H04N5/85 //H04N5/775, H04N9/804

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G11B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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P, A	---	5, 10
E	---	1, 5, 6, 10
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 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

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Date of the actual completion of the international search

Date of mailing of the international search report

23 November 2000

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/05715

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